Chapter 3
WATER RESOURCES AND SYSTEM OVERVIEW

REGIONAL HYDROLOGIC CYCLE

The main components of the hydrologic cycle for the Kissimmee Basin (KB) Planning Area include precipitation, evapotranspiration, and the resulting flow of surface water and ground water. The interaction between surface water and ground water is expressed as either recharge to or discharge from the aquifer system.

Precipitation and Evapotranspiration

The average rainfall in the KB Planning Area is about 50 inches per year. There is a wet season from June through October, and a dry season from November through May. The heaviest rainfall occurs in June or July, averaging 7.75 inches for the month; the lightest rainfall month is usually November or December, averaging 1.75 inches for the month (**Table 5**). On average, 64 percent of the annual rainfall occurs in the wet season. Historical rainfall data are presented in Appendix B.

Evapotranspiration (ET) is the sum of evaporation and transpiration. ET, like rainfall, is generally expressed in inches per year. Approximately 45 inches of water per year is returned to the atmosphere by evapotranspiration in South Florida. Precipitation minus ET is equal to the combined amounts of surface water runoff and average ground water recharge.

Surface Water Flow

Surface water flow includes inflow from areas adjacent to the planning basin and rainfall falling within the basin; storage; and outflow to Lake Okeechobee via the Kissimmee River.

There are several primary surface water features providing surface water drainage for the KB Planning Area. Reedy Creek, Shingle Creek and Boggy Creek, located in the northernmost section of the basin, are the primary drainage features for Orange and northern Osceola counties. The Alligator and Kissimmee Chain of Lakes act as the primary features in northern Osceola County. All of these features eventually connect to the Kissimmee River, which is the primary drainage feature of the basin.

Table 5. Mean Rainfall Data for Rainfall Stations in the Kissimmee Planning Area.

County	Rainfall Station	Average Annual Rainfall (inches)	Years and Period of Record	Maximum Monthly Rainfall		Minimum Monthly Rainfall		% Rain Falling in Wet Season	Primary DBKEY[a]
				inches	month	inches	month		
Glades	Moore Haven	48.72	56 1940-1995	7.69	Jun	1.60	Dec	65.8	06124
Highlands	Archbold	49.16	53 1929-1995	7.81	Jun	1.56	Dec	65.7	06205
	Avon Park	52.25	82 1902-1995	8.27	Jun	1.71	Nov	66.2	06136
	Lake Placid	49.73	50 1933-1995	8.05	Jun	1.47	Dec	65.8	06137
Okeechobee	Ft. Drum	50.96	40 1956-1995	7.61	Jun	1.72	Dec	63.8	06141
	Okeechobee	48.53	67 1922-1995	7.35	Jun	1.56	Dec	64.2	06196, 06152, 06070, 06020
Orange	Orlando	51.97	89 1900-1995	7.80	Jul	1.89	Nov	62.9	06185
Osceola	Kissimmee	49.63	81 1901-1995	7.46	Jul	1.95	Nov	62.7	06146, 06147
	Brooks Property	48.91	30 1963-1995	7.49	Jul	1.99	Apr	62.5	05813
	S-65	50.79	31 1965-1995	7.90	Jun	1.78	Dec	63.2	05940
Polk	Mountain Lake	50.95	61 1935-1995	7.82	Jul	1.96	Nov	62.5	06134
Overall average		50.14		7.75		1.75		64.1	

a. For those interested in accessing DBHYDRO. Missing data were replaced with data from nearby stations, when available. Some years were excluded when values were missing and no nearby stations were available.

In general, rainfall falling within the basin is directed to one of the hydrologic features mentioned above. There are, however, three sources of inflow from areas adjacent to the planning basin. These are Josephine and Arbuckle creeks, which flow into Lake Istokpoga, and surface water from the Horse Creek Basin which flows into Lake Hatchineha via Lake Marion Creek. All of these inflows primarily originate in areas located within the Southwest Florida Water Management District.

In some areas located in the Orlando metropolitan area, some surface water drainage is directed towards drainage wells, which discharge directly to the Floridan aquifer. These wells, constructed up until the 1970s, are generally limited to closed drainage basins in the Orlando area. There are about 400 drainage wells, which provide a significant portion of the aquifer recharge in the Orlando area. Most of these wells are in the SJRWMD, and are a potential water source option for the Orange-Osceola Area.

Ground Water Flow

The components which together comprise ground water flow in the KB Planning Area include: ground water inflow from the west; the difference between surface water inflow to and outflow from the KB Planning Area; and ground water discharge to the east and south.

Two aquifer systems underlie the KB Planning Area; the Surficial Aquifer System (SAS) and the Floridan Aquifer System (FAS). The SAS is exposed at the land surface and is primarily recharged by rainfall. It interacts with surface water features, such as rivers, canals, and lakes. The FAS is a deeper carbonate aquifer which is overlain by a confining layer in most areas of the basin. This deeper aquifer is the primary source of ground water for the basin. It is recharged by ground water inflow from outside the basin and recharge occurring in the Kissimmee Basin region. Aquifer discharge generally occurs along the Kissimmee River and floodplain and along the St. Johns River to the east (see **Plate 3**). This is discussed in more detail in the Surface Water/Ground Water Interactions section at the end of this chapter. The Floridan aquifer in other parts of the District are recharged by the ground water flow from the Kissimmee area. Identifying activities in the Kissimmee Basin that could reduce the volume of water moving into the Floridan aquifer in the Upper East Coast region was one of the recommendations of the Upper East Coast Water Supply Plan (SFWMD, 1998).

SURFACE WATER RESOURCES

Development of the Kissimmee Basin

The Kissimmee Basin has undergone over a century of development for drainage, flood control, and navigation. In 1884, the Atlantic and Gulf Coast Canal and Okeechobee Land Company dredged canals to connect Lake Tohopekaliga to Lake Okeechobee via Lakes Cypress, Hatchineha, and Kissimmee. The company also dredged another canal to connect Lake Okeechobee to the Gulf of Mexico through the Caloosahatchee River.

Major hurricanes swept across the state in 1926, 1928, 1945 and 1947. The storm of 1947 caused extensive flooding on the farms south of Lake Okeechobee, southeast coastal cities and suburbs, and in the Kissimmee Basin. The flooding of 1947 prompted the U.S. Congress to authorize the U.S. Army Corps of Engineers (USACE) to design and construct the Central and Southern Florida Flood Control Project (C&SF Project). The construction of the C&SF Project in the Kissimmee Basin began in 1962 and was completed in 1971. This resulted in the channelization of the 103 mile Kissimmee River into a 56 mile canal. In addition, the Kissimmee Chain of Lakes were connected, and structures were added to regulate water levels.

Water levels in the Kissimmee Chain of Lakes are managed according to a regulation schedule for each lake subbasin (see Appendix C). Typically, the regulation schedules vary from high stages in the late fall and winter to low stages at the beginning of the wet season. The minimum levels are set to provide for sufficient flood control storage and navigation depths.

Kissimmee River Restoration

Changes in the Kissimmee River's water quality, wetlands, and ecosystem due to channelization in the lower Kissimmee River Valley have been the subject of numerous federal, state, and local studies. The USACE's first feasibility study of restoring the Kissimmee River was started in 1978 in response to Congressional authority. The SFWMD also studied restoration from 1984 to 1990, and the federal government conducted a second feasibility study from 1990 to 1992.

As a result of these studies, the Kissimmee River restoration project was developed with the goal to restore the ecological integrity of the river and floodplain ecosystem. To achieve this goal, the physical form and the historic hydrology of the system had to be re-created. The two primary components of the restoration project that provide the basis for this project are the headwaters revitalization and lower basin backfilling. The headwaters revitalization will modify the way water is released to the river in an effort to simulate historic flow conditions. The lower basin backfilling will fill the middle portion (22 miles) of C-38, and re-create the river's physical form and flows.

Surface Water Features

The KB Planning Area is divided at the outlet of Lake Kissimmee into upper and lower basins. The Upper Kissimmee Basin includes 17 subbasins while the Lower Kissimmee Basin includes 9 subbasins (see Appendix C for specific information on subbasins). A detailed map of the major surface water features, including lakes, rivers, canals, and structures is provided as **Plate 2**.

Upper Kissimmee Basin

The Upper Kissimmee Basin is dotted with hundreds of lakes, ranging in size from less than an acre to over 55 square miles (Lake Kissimmee). The surface water drainage includes a series of interconnected lakes in its northern portion, called the Kissimmee Chain of Lakes. Alligator Lake forms the drainage divide of the chain of lakes and water can be released either to the north or to the south from this point. Water flows north through several canals and smaller lakes to Lake Mary Jane; the flow proceeds through Lakes Hart, East Tohopekaliga, and Tohopekaliga, then finally to Cypress Lake. Southward flow travels a shorter route through Lake Gentry and then to Cypress Lake. From Cypress Lake, water flows southward to Lake Hatchineha and then to Lake Kissimmee. Most of these lakes are shallow, with mean depths varying from 6 to 13 feet.

The major streams feeding into the Kissimmee Chain of Lakes are Shingle Creek, Reedy Creek, and Boggy Creek. The headwaters for these creeks are located in urban areas. From here, flow moves through wetlands on the way into their respective lakes.

The headwaters of Shingle Creek are formed in the city of Orlando. The creek then runs southward for 24 miles through Shingle Creek Swamp and the city of Kissimmee before emptying into Lake Tohopekaliga. About 13 miles of the creek, from its headwaters to just south of the swamp, have been channelized.

Reedy Creek originates in Walt Disney World, then runs southeast for 29 miles before splitting into two branches near Cypress Lake. One branch enters Cypress Lake and the other enters Lake Hatchineha. During most of its course, the creek flows through Reedy Creek Swamp.

Boggy Creek has two main branches: East and West. The East Branch, which is 12 miles in length, is the main watercourse of Boggy Creek. The headwaters of this branch are formed in the city of Orlando northwest of Orlando International Airport. The East Branch runs through Boggy Creek Swamp before emptying into East Lake Tohopekaliga. The headwaters of West Branch originate in another highly urbanized area of Orlando (Lake Jessamine). The West Branch flows to Boggy Creek Swamp.

Lower Kissimmee Basin

The Lower Kissimmee Basin includes the tributary watersheds of the Kissimmee River between the outlet of Lake Kissimmee (S-65) and Lake Okeechobee. The Kissimmee River and Lake Istokpoga are the major surface water features in the basin. Fisheating Creek and Taylor Creek/Nubbin Slough are prominent surface water features in the southern region of the KB Planning Area. Fisheating Creek marks the southernmost extent of the KB Planning Area and flows into Lake Okeechobee. Taylor Creek/Nubbin Slough is the site of one of the priority clean-up projects identified as part of the Okeechobee Surface Water Improvement and Management (SWIM) and Everglades restoration projects. There are no known large uses of water from either creek. Information on these streams is available in the Lake Okeechobee SWIM Plan (SFWMD, 1997).

The Kissimmee River was originally 103 miles in length until it was channelized in the 1960s into a 56 mile canal (C-38). Currently, the Kissimmee River is divided into five pools (pools A-E) by a series of combined locks and spillways. The water level in each of these pools is regulated according to an interim regulation schedule (**Plate 2**). The Kissimmee River Restoration Project, which is underway, will backfill 22 miles of the C-38 Canal, directing flows through the historic river channel and restoring the ecological functions of the river/floodplain system. Backfilling will begin midway between S-65A and S-65B and will end just north of S-65D.

Lake Istokpoga at 44 square miles, is the fifth largest lake in Florida. The lake is connected to the Kissimmee River via the Istokpoga Canal and the C-41A Canal. The Istokpoga Canal consists of two reaches, one upstream and one downstream of the G-85 Structure. The Istokpoga Canal drains into the Kissimmee River approximately 1.5 miles upstream of the S-65C Structure. These structures will be removed as part of the Kissimmee River Restoration Project. Rate of flow in the Istokpoga Canal is controlled by the G-85 Control Structure. The Istokpoga Canal will be modified and the G-85 Structure, which maintains the stage of Istokpoga Canal, will be replaced with a gated spillway. The restoration project is expected to re-establish the historic hydrology of the river and floodplain in areas north of the S-65E Structure. As a result, water surface elevations in the lower reach of the Istokpoga Canal, downstream of the G-85 Structure, are expected to fluctuate seasonally.

The main outlet for Lake Istokpoga is S-68, which regulates discharges from the lake to the C-40, C-41, and C-41A canals. The C-41A Canal discharges into the Kissimmee River below S-65E, passing through two additional water control structures (S-83 and S-84). The C-41 and C-40 canals also assist in discharging water from Lake Istokpoga draining to Lake Okeechobee. The C-40, C-41, and C-41A canals and associated structures make it possible to regulate the stages of Lake Istokpoga for irrigation water supply. Tests performed by the USACE, USGS, and SFWMD showed design deficiencies in the S-68, S-83, and S-84 structures (Abtew, 1992). These structures will be enlarged to allow design discharges from the lake. The USACE, Jacksonville District, is responsible for design and construction of structure modifications. The modifications at S-68 include adding a single bay spillway. Modifications at the S-83 and S-84 structures include the addition of a tailwater weir. Construction is scheduled to begin in early 2000 on the G-85 structure with modifications to the other structures to follow.

GROUND WATER RESOURCES

The hydrogeology of South Florida is best defined as a series of layered aquifers and aquitards that vary in thickness and depth. This includes both semi-confined and unconfined aquifers. For the Kissimmee Basin and surrounding areas, ground water is the main source of water supply. In Central Florida, three aquifers with varying water supply potential exist. They are the Floridan Aquifer System (FAS), Intermediate Aquifer System (IAS), and the Surficial Aquifer System (SAS). Within an individual aquifer, hydraulic properties and water quality may vary vertically and horizontally. The aquifers in each of the counties in the basin and surrounding areas are described below.

Orange County

There are two important ground water systems in Orange County, the SAS and the FAS. **Table 6** provides a description of the relative positions and productivity of each hydrologic component.

The SAS occurs throughout Orange County, and is capable of producing small to moderate amounts of water at a rate generally under 20 GPM. The SAS ranges in thickness from just a few feet to in excess of 100 feet and is used in some portions of the county as a source of residential self supply. Due to the low yield, the SAS is not considered a regional supply source in Orange County.

The IAS underlies the SAS and consists primarily of fine sands and silts of the Hawthorn Group and Tampa Formation. This aquifer system has a low permeability and separates the SAS from the underlying FAS. The IAS confines the FAS which is under

Table 6. Ground Water Systems in Orange County.

Hydrogeologic System	Geologic Unit	Thickness (feet)	Water Resource Potential
Surficial Aquifer System	Undifferentiated clastic deposits	0-100	Yields low to moderate amounts of water to wells. Used sporadically as a source of individual domestic supply in a few areas.
Intermediate Aquifer System	Hawthorn Group Confining Beds	50-250	Acts as a confining zone for the underlying Floridan Aquifer System. A few locally occurring producing zones exist, but they do not produce large amounts of water. Some limited domestic use occurs.
Upper Floridan Aquifer	Ocala Limestone and Avon Park Limestone	200-400	Capable of producing large amounts of water. Susceptible to local contamination as a result of receiving surface runoff through drainage wells.
Middle Semi-Confining Unit	Lower Avon Park and Upper Lake City	300-700	Unit separating the upper and lower producing units.
Lower Floridan Aquifer	Lake City and Oldsmar Limestone	1,100-1,600	Yields generally exceed 2,000 GPM, Yield can be less predictable than the upper zone as less is known about this aquifer.

artesian pressure. Locally occurring sand or limestone lenses within the IAS may produce moderate amounts of water and is typically used for residential self-supplied use.

The FAS is composed primarily of limestone and dolomite and provides nearly all of the ground water used in Orange County. The FAS behaves as a confined or semi-confined aquifer in all portions of the county. The FAS contains two producing zones, the Upper and Lower Floridan aquifers. These units are separated by the middle semi-confining unit, which has a comparatively lower yield. Both the Upper and Lower Floridan aquifers are capable of yielding large amounts of water. Water in the Upper Floridan aquifer is of potable quality throughout the county except for the extreme east section along the St. Johns River. The Lower Floridan aquifer is also fresh in all but the eastern portion of the county, where it is brackish. The Lower Floridan aquifer also contains gypsum mineralized waters in the southwest portion of the county (letter dated November 24, 1999 from Herb Stangland Jr., Ardaman and Associates Inc., Orlando, FL).

Osceola County

There are two ground water systems in Osceola County, the SAS and the FAS. **Table 7** provides a description of the relative positions and productivity of each hydrologic component.

Table 7. Ground Water Systems in Osceola County.

Hydrogeologic System	Geologic Unit	Thickness (feet)	Water Resource Potential
Surficial Aquifer System	Undifferentiated clastic deposits	20-270	Yields low to moderate amounts of water to wells. Not a major water source in Osceola County. Water quality varies widely.
Intermediate Confining Unit	Hawthorn Group	10-370	Acts as a confining zone for the underlying Floridan Aquifer System. There may be limestone units within the Hawthorn Group, which may produce moderate amounts of water. These units have not been studied extensively.
Upper Floridan Aquifer	Ocala Group and Avon Park Limestone	100-500	Capable of producing large amounts of water. In general, the upper zone produces more water than the lower zone.
Middle Semi-Confining Unit	Lower Avon Park and Upper Lake City	450-700	Acts as a confining zone for the lower producing zone, although capable of producing significant amounts of water in some areas of the county.
Lower Floridan Aquifer	Lake City Limestone	1,400-2,100	Capable of producing large amounts of water. Water quality limitations on the eastern side of the county.

The SAS occurs throughout Osceola County thickening from the northwest section of the county towards the southeast. The SAS is capable of producing small to moderate amounts of water, generally not exceeding 20 gpm. Due to the low yield, the SAS is not considered a regional supply source in Osceola County.

The IAS underlies the SAS and consists primarily of fine clastics. This layer is characterized by having a low permeability, separating the SAS and the underlying FAS systems. This unit acts a confining zone or cap to the FAS allowing for the development of artesian pressure in the FAS. Locally occurring sand or limestone lenses within the IAS may produce moderate amounts of water for residential self-supplied use.

The FAS is a limestone and dolomite aquifer system providing nearly all of the ground water used within Osceola County. The FAS contains two producing zones, the Upper Floridan and Lower Floridan aquifers. These units are separated by the middle semi-confining unit, which has a comparatively lower yield. Both the Upper Floridan and Lower Floridan aquifers are capable of yielding large amounts of water. The Lower Floridan aquifer does appear to have a limited production capability in the northwest portion of the county where lithologic changes in the aquifer appear to reduce the porosity of the limestone. Water within the Upper Floridan aquifer is of potable quality throughout the county. The Lower Floridan aquifer is also fresh in most areas, but exhibits poorer water quality in the extreme eastern portion of the county located outside the basin KB Planning Area. The development of water supplies in these areas will likely require additional levels of water treatment. Recent wells drilled in the southwest portion of the county have also discovered gypsum mineralized waters in portions of the Lower Floridan aquifer.

Polk County

The FAS, IAS, and SAS are the three aquifer systems in Polk County. The relative positions and production capabilities of these aquifer systems are described in **Table 8**.

The SAS produces small quantities of good-to-fair quality water, better than other counties within the KB Planning Area. Generally, it is moderately to highly acidic, has high concentrations of dissolved iron, and is colored. Isolated areas may also contain elevated levels of natural radiation stemming from the weathering of phosphorite deposits. Wells drilled into the surficial aquifer rarely yield more than 100 GPM, and average closer to 25 GPM. Though hundreds of wells tap the SAS, these wells are limited to the central ridge areas where the aquifer is thickest. Water use from the aquifer is for residential self-supply, lawn irrigation, and small scale agricultural irrigation.

The IAS consists of limestone and dolostones of the Hawthorn Group and Tampa Member. It is confined by low permeability silts and clays. In a portion of Polk County, the lower Tampa confining beds are thin or absent and the Tampa Member of the IAS and FAS appear to be connected. Water from the IAS is used primarily for residential self supply, but is also used for livestock watering, small public utilities, and agricultural irrigation. Most irrigation wells penetrating the upper FAS are open to the Intermediate aquifers as well. Average well yields range from 25 GPM in small diameter domestic wells to more than 200 GPM in large diameter irrigation wells. Water quality is generally within potable standards, except for isolated areas which have excessive hardness. Some areas may show elevated concentrations of natural radiation, resulting from weathered phosphorite deposits.

The upper portion of the FAS is the principal source of all major municipal, industrial, and irrigation water supplies. Large wells tapping the Floridan aquifer have yielded as much as 8,000 GPM of potable quality water. Polk County is an important recharge area for the FAS. Primary recharge areas occur along a linear band associated with the sandy Lake Wales Ridge.

Highlands County

The FAS, IAS, and SAS are the three aquifer systems in Highlands County. The relative positions and production capabilities of these aquifer systems are described in **Table 9**.

Yields from the SAS vary considerably with location, but are generally less than 100 GPM. This aquifer furnishes water for cattle watering and residential self-supplied residents throughout the county. The SAS produces potable quality water, with the exception of isolated areas with high iron and organic concentrations.

Table 8. Ground Water Systems in Polk County.

Hydrogeologic System	Geologic Unit	Thickness (feet)	Water Resource Potential
Surficial Aquifer System	Undifferentiated clastic deposits	10-100	Produces small quantities of relatively good quality water. Most wells yield less than 50 GPM. Use is restricted to residential self supply, lawn irrigation and small scale agricultural irrigation.
Intermediate Aquifer System	Hawthorn Group	10-300	Used primarily for residential self supply, livestock watering, and small public utilities. The aquifer produces small to moderate quantities of potable quality water. Most productive in the central and southern portions of the county.
Upper Floridan Aquifer	Tampa Member, Suwannee and Ocala Limestones, Upper portion of Avon Park	300-600	Principal aquifer in Polk County. Supplies all major municipal, industrial, and irrigation water demands. Produces large quantities of good quality water. Eastern portions of the county experience artesian conditions.
Middle Semi-Confining Unit	Lower Avon Park, Lake City Limestone	200-400	Lower yielding portions of the Avon Park, introduction of dolomites reduces permeabilities.
Lower Floridan Aquifer	Lake City and Oldsmar Limestone	>600	Little is know of this portion of the Floridan system, as it is not extensively used. It is believed that transmissivity for the aquifer is less than that of the upper section.

The IAS contains isolated beds of sand and gravel, which yield large amounts of good quality water. These beds are important water supply sources to localized areas along the upland ridge. Since these producing zones are discontinuous, however, the IAS is not generally regarded as an important source of either public or large agricultural water supply for most of Highlands County. Rather, this aquifer is used primarily for domestic purposes.

The FAS is the single most important source of water in Highlands County. It is composed of several zones with varying productivity. Wells tapping the most productive zones of the FAS are capable of yielding 500 to 1,500 GPM. Water quality varies with depth and location, becoming increasingly mineralized with depth and distance to the south. With the exception of the southeast corner of the county, water quality suitable for most uses can be found as deep as the Lake City Limestone (**Table 9**). All major potable water systems in Highlands County withdraw from the FAS, except for the city of Lake Placid, which gets its water from Lake Sirena. The FAS is also the predominant source of water for citrus irrigation.

Table 9. Ground Water Systems in Highlands County.

Hydrogeologic System	Geologic Unit	Thickness (feet)	Water Resource Potential
Surficial Aquifer System	Undifferentiated clastic deposits and Tamiami Formation	40-200	Except for isolated areas with high iron and organics, produces small to moderate amounts of good quality water. Furnishes residential self supplied and livestock watering locally throughout the county.
Intermediate Aquifer System	Hawthorn Group	300-650	Confining unit for the Floridan Aquifer System. Isolated beds of sand and gravel yield large amounts of water locally along the ridge, but they are discontinuous. Not an important source of water over most of the county.
Floridan Aquifer System	Suwannee Limestone Ocala Limestone Moody's Branch Formation Avon Park Limestone Lake City Limestone Oldsmar Limestone Cedar Keys Limestone	0-80 150-250 50-150 200-300 >400 >600 >670	Most important source of water in Highlands County. Productivity tends to increase with depth. TDS, sulfates, and chloride concentrations increase with depth and distance to the south from the Highlands Ridge, but water of a quality acceptable for most uses can be found as deep as the Lake City Limestone. Water is too highly mineralized for most purposes.

Okeechobee County

There are two major ground water systems in Okeechobee County, the SAS and the FAS. **Table 10** shows the relative positions and production characteristics of these two systems.

The SAS is the major source for domestic self-supplied use in Okeechobee County. It is also used to supply livestock. Productivity in the aquifer tends to increase with depth, but most wells yield less than 100 GPM. Productivity of the SAS is significantly lower in the western portion of the county near the Kissimmee River. Water from the surficial aquifer is generally potable with minimal treatment, except in the southeast portion of the county, where chloride concentrations in excess of 250 mg/L have been measured (Parker et al., 1955).

Separating the SAS from the FAS is the IAS comprised of the Hawthorn Group. The IAS contains some isolated beds of sand and gravel which together yield minor quantities of good quality water. However, the lenses are more limited than in other counties and the IAS is not generally regarded as an important source of water supply for public or agricultural uses. Rather, it is used for primarily for domestic purposes.

Table 10. Ground Water Systems in Okeechobee County.

Hydrogeologic System	Geologic Unit	Thickness (feet)	Water Resource Potential
Surficial Aquifer System	Undifferentiated clastic deposits	100-240	Yields small quantities of good quality water, except near Lake Okeechobee where chloride concentrations exceed potable standards. Wells commonly yield 100 GPM or less. The SAS is the primary source of potable water in unincorporated areas.
Intermediate Aquifer System	Hawthorn Group	200-600	Does not yield significant quantities of water within Okeechobee County.
Upper Floridan Aquifer Middle Floridan Unit Lower Floridan Aquifer	Ocala and Avon Park Limestone Formation	860-960	Produces large to moderate quantities of water, with productivity increasing to the north. Wells generally yield more than 200 GPM. Water quality varies, ranging from very good in the north to brackish in the south and east. The FAS is the primary source of supply of agricultural uses. Sodium, chloride, TDS, and sulfate concentrations increase with depth throughout the county. Little information is available about this unit. Little is known about this aquifer because few wells penetrate this unit. Water quality is generally known to be poor exceeding chloride concentrations of 1,000 mg/L in locations.

The FAS is the principal water source used for irrigation and cattle watering in Okeechobee County. Transmissivities within the aquifer vary significantly throughout the county, ranging from 2,000 gallons per day per unit foot (GPD/ft) in the south to more than 500,000 GPD/ft in northern Okeechobee County. Generally, sodium, chloride, TDS, and sulfate concentrations increase with depth and distance to the south. In the central and northern portion of the county, FAS water is of good quality, requiring little to no treatment for potable use. Waters in the southern and eastern portions of the county; however, may contain localized chloride concentrations in excess of 1,000 mg/L. Although FAS waters are not potable in some areas, they are used extensively for irrigation throughout the county.

Glades County

Three aquifer systems have been identified in Glades County; the SAS, the IAS, and the FAS. **Table 11** shows the relative positions and productivities of these systems.

Little data have been documented on the water bearing characteristics of these aquifer systems in Glades County.

Table 11. Ground Water Systems in Glades County.

Hydrogeologic System	Geologic Unit	Thickness (feet)	Water Resource Potential
Surficial Aquifer System	Undifferentiated clastic deposits	20-100	Varies widely in productivity. Near Lake Okeechobee the shallow ground water is high in chlorides. Moore Haven obtains its potable water from the surficial aquifer.
	Tamiami Formation	0-100	Source of some domestic and stock supply wells.
Intermediate Aquifer System	Equivalent to the sandstone aquifer of Hendry and Lee counties	90-230	Low to moderate productivity. Supplies water for residential self-supplied use and for irrigating small citrus groves.
Floridan Aquifer System	Suwannee Limestone Ocala Limestone	270-1,200	Artesian flow through much of the county. High productivity. Potable in the north to unsuitable for irrigation in the south. Chloride, TDS, and sulfate concentrations increase with depth throughout the county.

The SAS generally has low-to-moderate permeability and productivity. Near the Caloosahatchee River, the shallow ground water contains relatively high chloride and dissolved solids concentrations. The city of Moore Haven obtains its potable water from the SAS.

In the southwest corner of the county, an aquifer exhibiting low-to-moderate productivity exists in the IAS. The IAS is used for residential self supply, as well as for irrigation by several small citrus groves in the area. Little data is available on the IAS for the rest of the county.

The FAS underlies all of Glades County. It consists of several aquifers or producing zones capable of yielding large volumes of water. Floridan wells are under artesian pressure over much of the county. Water quality in the FAS varies from potable in the north to unpotable and unsuitable for most irrigation uses to the south along the Hendry County boundary. Generally, chloride, TDS, and sulfate concentrations increase with depth in the FAS throughout the county.

SURFACE WATER/GROUND WATER INTERACTIONS

The relationship between a surface water feature and the underlying ground water system is one of the most difficult hydrologic relationships to understand. This relationship is based upon the hydraulic characteristics of each aquifer and the thickness and type of soils separating the two features. When a river, canal, or wetland has a higher water level than the water table, these surface water bodies provide seepage into the local shallow ground water system. Conversely, when the water level of the surface water bodies are lower than the water table, ground water discharge may occur. The rate at which this transfer occurs is dependent upon the difference in these two levels and permeability and thickness of the materials separating the two aquifers.

The FAS experiences both natural and artificial recharge. Natural recharge of the FAS within the KB Planning Area is greatest along the Lake Wales, Mount Dora and Bombing Range ridges (**Plate 3**). These areas represent locations where the differences in surface and FAS levels are greatest, and the thickness of the IAS is thinnest or breached by karst activity. Recharge areas are often evident as potentiometric highs on the surface of the FAS. **Figure 6** shows the potentiometric surface of the FAS in May 1997. This is not always the case however. The potentiometric high located in Polk County is not a high recharge, but is instead an artifact of the several surrounding discharge areas.

A large, flat surface in the potentiometric surface of the FAS is indicative of individual recharge areas (letter dated November 24, 1999 from Herb Stangland Jr., Ardaman and Associates Inc., Orlando FL). Along the eastern part of the Green Swamp, high recharge occurs in the sand-filled cavities that extend into the top of the Upper Floridan aquifer along U.S. Highway 27 at the edge, and not in the middle of Green Swamp.

There are about 400 drainage wells in the city of Orlando that discharge into the FAS. Approximately 50 percent of the water these drainage wells receive is from direct stormwater runoff; another 30 percent is from lake overflow; while 15 percent is from excess overflow from wetlands; and the remaining 5 percent is from unused wells that in the past were used to dispose of industrial effluent, sewage and air conditioner return water (SFWMD, 1992).

Springs occur at locations where there is a direct location between an aquifer and surface waters. Florida has more springs than any other state, with 27 first magnitude springs having an average flow of 65 MGD or more. The state also has 49 springs with an average flow of between 6.5 and 65 MGD (Rosenau et al., 1977). These major springs result from the upward movement of water from the FAS in areas where the artesian pressure in the aquifer is elevated above the land surface.

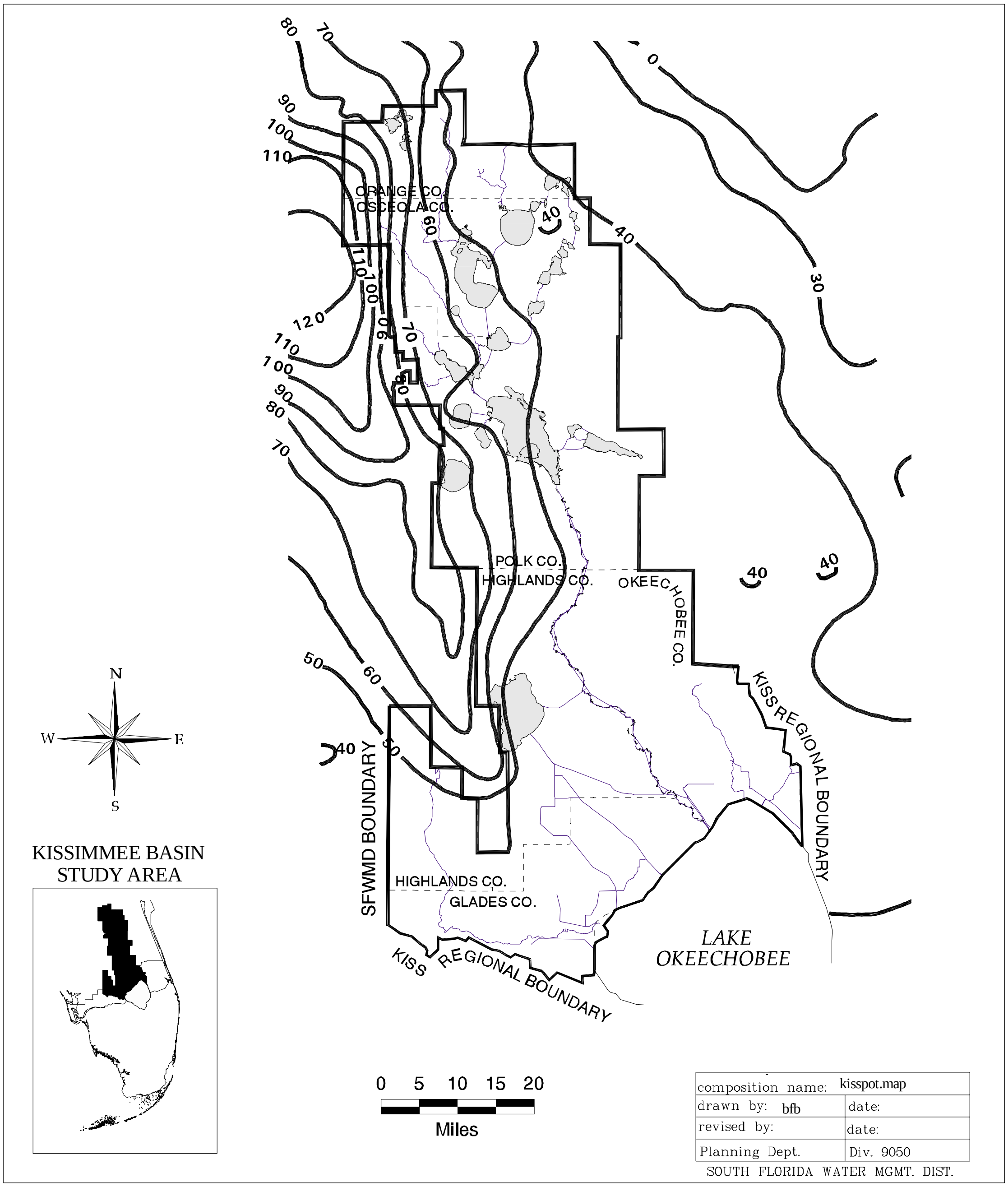

Figure 6. Potentiometric Surface of the Floridan Aquifer System, May 1997.